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NUCLEAR DIVISION

NERVA
LOGISTICS SUPPORT PLAN
L - 003

L003-SS-~~09205-F1~~ 090205-F1

NERVA PROGRAM CONTRACT SNP-1

30 SEPTEMBER 1969

NUCLEAR ROCKET OPERATIONS

AEROJET
GENERAL TIRE
GENERAL

NERVA
LOGISTICS SUPPORT PLAN
L - 003

L003-SS-09205-F1

NUCLEAR ROCKET OPERATIONS

NERVA PROGRAM CONTRACT SNP-1

30 SEPTEMBER 1969

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Classification Category
UNCLASSIFIED

Classifying Officer 9/24/69 Date

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ACKNOWLEDGMENT

In the preparation of this plan, a substantial contribution was made by the principal NERVA subcontractor, the Westinghouse Astronuclear Laboratory.

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APPENDIX

1.0 SCOPE

1.1 PURPOSE

The purpose of this plan is to identify the actions required for logistics support that ensure that the NERVA engine is maintained, provisioned, and transported in accordance with the requirements of the NERVA-engine program and the logistics provisions of SNPO-NPRD-1. This plan delineates the philosophy of the NERVA-engine logistics program and facilitates integration of the NERVA-engine program into the overall NERVA program.

1.2 APPLICABILITY

This plan applies to all phases of the NERVA program through mission completion. The plan conforms with the requirements of the SNPO-NPRD and reflects the output of the system engineering process, AFSCM 375-5. This data item also defines the NERVA contractor's responsibilities and scope, and the contributions of others needed to support the program.

1.3 EXPLANATION OF TERMS

Appendix A contains an explanation of the terms used in this plan.

2.0 APPLICABLE DOCUMENTS

The procedures and requirements of the following documents (of the issue in effect on the date of this publication) form a part of this plan to the extent specified herein.

2.1 FEDERAL

Atomic Energy Commission Manual, AEC Chapter 0529: "Safety Standards for the Packaging of Radioactive and Fissile Materials."

Department of Transportation Regulations for Transportation of Explosives and Other Dangerous Articles by Land and Water, in Rail Freight Service, and by Motor Vehicle (Highway) and Water including, "Specifications for Shipping Containers" (Title 49, Code of Federal Regulations Parts 170-179).

2.2 MILITARY

AF Form DD 250: Material Inspection and Receiving Report

AFSCM 375-1: Configuration Management During Definition and Acquisition Phases

AFSCM 375-5: Systems Engineering Management Procedures

MIL-P-116E: Methods of Preservation

MIL-STD-129D: Marking for Shipment and Storage

MIL-P-9024E: Packaging, Materials Handling and Transportability, System Segments, General Specification for

MIL-STD-167: Mechanical Vibrations of Shipboard Equipment

MIL-STD-810: Environmental Test Methods

MIL-F-7179C: Finishes and Coatings, General Specification for Protection of Aerospace Weapons Systems, Structures and Parts

2.3 STATE

To be supplied

2.4 GOVERNMENT CONTRACTING AGENCY

"NERVA Program Requirements Document," SNPO-NPRD-1, 1 July 1969

"Logistics Support Plan," L-3, August 1969, Data Item Description, Form 9

2.5 OTHER

Aerojet

R-102-SS-09205-F1 NERVA Maintainability Program Plan

- * - The NERVA Site Activation Plan
- * - Maintainability Allocations, Assessment, and Analysis Report
- * - Test Support Equipment/Aerospace Ground Equipment Plan
- * Functional Flow Diagrams
- * Requirement Allocation Sheets
- * Requirements/Design Trade Study Reports

Westinghouse

TME * Engineering Data (Category A) for Design Evaluation, Nuclear Subsystem

*To be supplied

3.0 REQUIREMENTS

3.1 LOGISTICS RESPONSIBILITY

The logistics responsibility of each of the organizations in the NERVA-engine logistics program is defined herein to provide continuity of management and eliminate duplication of functions.

3.1.1 Engine Contractor

The Engine Contractor, Aerojet-General Corporation (AGC) is responsible for the following functions:

1. Integration and implementation of the total NERVA-engine logistics support plan, insuring the compatibility of all logistics elements, subcontractor, and stage contractor logistics interfaces.

2. Coordination with the Government Contracting Agencies (GCA) to develop NERVA-engine logistics requirements, logistics documents, and, when appropriate, present additional requirements, and/or changed requirements to the GCA.

3. Convene and conduct meetings with subcontractors, stage contractors, or facility host organizations (FHO) to accomplish effective NERVA-engine logistics support.

3.1.2 NERVA Nuclear Subsystem Principal Subcontractor

The Westinghouse Astronuclear Laboratory is the principal subcontractor with responsibility for the NERVA Nuclear Subsystem (NSS). As such, the use of the term "engine contractor" throughout this plan implies WANL participation and/or support in this role for any activities, operations, facilities, or equipment related to the NERVA NSS.

3.1.3 Stage Contractor

The stage contractor is responsible for providing the engine contractor with the data requisite to that organization's logistic needs.

3.1.4 Government Contracting Agency

The Government contracting agency (GCA) is responsible for the following functions:

1. Ensures that each FHO having a responsibility for any part of this plan adheres to its implementation and fulfills its responsibilities.

2. Ensures that timely review and approval, or review and concurrence, at the programmatic milestones associated with logistics are provided. The GCA also provides Government-owned facilities and Government-furnished propellants scheduled "need-dates".

3. Ensures that all NERVA-engine program logistics support required at the various program facilities is available in time to conduct engine operations as scheduled.

3.1.5 Plans for Site Activation

AGC provides the GCA or FHO with site activation requirements, including the space, material, and storage requirements needed to perform the SNPO-NPRD-1-directed program activities. The site-activation-requirements data to be provided are developed by the engine contractor.

3.1.5.1 Ground Test Program

The Nuclear Rocket Development Station (NRDS) requirements data are developed by the engine contractor. Facilities that are to be operated by NERVA Test Operations (NTO), a joint AGC-WANL organization, are activated in accordance with approved activation plans and procedures prepared by NTO.

3.1.5.2 Flight Program

The engine contractor prepares NERVA-engine assembly, acceptance-test, and launch-facility activation requirements. These requirements are submitted to the GCA and/or stage contractor, as appropriate, for inclusion into the facility-activation plans of the Government agency (or its contractors) responsible for implementing site activation.

3.2 MAINTENANCE PROGRAM

The objective of this section is to establish the NERVA-engine-program maintenance criteria goal so that NERVA-engine "downtime" does not exceed the following:

	Scheduled Activity	Allowable "Downtime"
1.	Engine Assembly	2 weeks
2.	Engine Acceptance	1 week
3.	Stage Assembly and Acceptance Test	1 week
4.	Vehicle Assembly and Acceptance Test	2 days (48 hours)
5.	Launch Place of Airborne Debarkation (RAD) Operations (T-50 days to T 0.0 sec)	2 hours
6.	Flight Operations	0 time

Maintainability design and analysis and maintenance analyses are performed and documented in the NERVA functional flow diagrams, requirement allocation sheets, maintainability program plan, and maintainability allocations, assessments and analysis reports (NERVA data items S-52, S-53, R-102 and R-201). These data items are updated so that maintenance experience gained during the development and qualification test programs is available for application during the engine flight program.

3.2.1 Maintenance Policies

This plan contains data used as criteria to establish the NERVA-engine maintainability program plan. The effective implementation of this program requires that each NERVA contractor be responsible for the maintenance of his equipment. Agreements between contractors for performance of maintenance actions do not relieve a contractor of his responsibility for his equipment's performance. All maintenance of the NERVA engine and its TSE-AGE is performed by qualified, contractor-trained personnel using approved procedures and equipment. The personnel are trained and procedures developed in accordance with NERVA data items identified by the GCA.

3.?.1.1 Maintenance Concept

The maintenance program is based on a concept of:

1. Field and organizational maintenance bein, accomplished by contractor field-service personnel whose knowledge and skills are equal to those of the personnel at the contractor's plant who are performing the same function.

2. Minimum maintenance at the launch site and test stands, consisting primarily of engine-component replacement.

3. Preventive maintenance and servicing are employed in cases where it can be shown that optimum engine-subsystem and component designs result from its application.

3.2.1.2 Maintenance and Repair Cycles

NERVA-engine maintenance is performed in cycles that are either preventive, corrective, or those that encompass servicing. The specific functions in each cycle are determined from an engine analysis performed in accordance with AFSCM 375-5, Exhibit 2. The NERVA-engine maintenance cycles are:

1. Preventative - That maintenance which is accomplished at scheduled intervals.

2. Corrective - That maintenance which is accomplished as its need is identified.

3. Servicing - Those actions which are accomplished at predetermined intervals, so these intervals do not adversely affect NERVA program activities.

3.2.1.3 Repair, Modification and Overhaul

Repair or overhaul criteria necessary for rework are specified in the NERVA, "Maintainability Allocations, Assessments, and Analysis Report." Modifications to NERVA engine equipment are performed as directed by GCA-approved engineering change proposals (ECP).

3.2.1.4 Criteria for Acceptance of Repaired Items

Repaired components must meeet all requirements specified in design sheets or specifications for newly fabricated hardware.

3.2.2 Maintenance Levels

NERVA-engine maintenance is performed at three task-capability levels: organizational, field, and depot. These levels are defined as follows:

1. Organizational-Level Maintenance - That maintenance performed at the test cell(s), test stand(s), or launch PAD. It consists of troubleshooting, alignment, calibration, inspections, preventive maintenance checks, and the removing and replacing of components.

2. Field-Level Maintenance - That maintenance performed in the engine, engine-subsystem, stage, and/or vehicle assembly area. It consists of component bench checks, functional-acceptance checks, testing and periodic calibration, and the repair and replacing of components.

3. Depot-Level Maintenance - That maintenance normally performed at the contractor's facility. It involves major overhaul and repair or complete rebuilding. However, depot-level maintenance may sometimes be performed in the field by depot mobile-maintenance teams from the contractor's depot.

3.2.2.1 Ground Test Program

3.2.2.1.1 Aerojet-General Corporation, Sacramento, California

The AGC Sacramento Facility, a NERVA-engine depot, has the capability of performing all levels of engine non-nuclear subsystem and component during the ground test program maintenance; i.e., modify, overhaul, and repair the non-nuclear subsystems, components, and related TSE/AGE. Rework of engine subsystems and components returned to Sacramento is performed in accordance with the existing AGC maintenance procedures governing "returned products."

3.2.2.1.2 Westinghouse Astronuclear Laboratory, Large, Pennsylvania

At the WANL, Large Facility, a nuclear subsystem depot has the capability of performing all levels of NSS maintenance not requiring remote operation during the ground test program; i.e., modify, overhaul, and repair of the NSS subsystem components, and related TSE/AGE. Rework of NSS components returned to Large is performed in accordance with applicable maintenance procedures governing "returned products."

3.2.2.1.3 Nuclear Rocket Development Station (NRDS), Jackass Flats, Nevada

NRDS has the capability of performing field and organizational maintenance to support the NERVA engine and NSS module development and qualification test programs at the following locations:

1. Engine Assembly and Maintenance Building (E-MAD)

   Field and organizational maintenance is performed at the E-MAD Facility.

2. Engine Test Stand (ETS-1)

Organizational maintenance is performed at ETS-1 Facility.

3. Test Cell C (TCC)

Organizational maintenance is performed at the TCC "C" Faility.

3.2.2.2 Flight Program

3.2.2.2.1 Aerojet-General Corporation, Sacramento, California

The AGC Sacramento Facility is a depot during the NERVA-engine flight program. Modification, overhaul and repair of non-nuclear subsystems, components, and their related AGE are accomplished at the Sacramento Facility.

3.2.2.2.2 Westinghouse Astronuclear Laboratory, Large, Pennsylvania

The WANL, Large Facility is a depot for the NSS during the NERVA-engine flight program. Modification, overhaul, and repair of the NSS, subsystem components and related AGE are accomplished at the Large Facility.

3.2.2.2.3 Assembly Site

The assembly site has the capability of performing organizational and field maintenance.

3.2.2.2.4 Acceptance Site

The acceptance site has the capability of performing organizational and field maintenance.

3.2.2.2.5 Launch Site

The launch site has the capability of performing organizational and field maintenance.

3.2.3 Precision Measurement Equipment Laboratory

3.2.3.1 Ground Test Program

The NERVA engine, its subsystems, components, and associated TSE/AGE require calibration at NRDS. Engine contractor personnel remove engine instrumentation requiring calibration and forward it to the FHO standards laboratory, where it is calibrated in compliance with NERVA-engine program calibration procedures.

3.2.3.2 Flight Program

The NERVA engine, its subsystems, components, and associated AGE have instrumentation which requires calibration at the assembly, acceptance, and launch sites. Engine-contractor personnel remove NERVA-engine instrumentation requiring calibration and ship it to the applicable FHO standards laboratory, where it is calibrated in compliance with NERVA-engine approved procedures and specifications.

3.2.4 Maintenance Procedures

The engine contractor provides procedures covering all phases of NERVA-engine test and maintenance activities at assembly, acceptance, and launch sites. The procedures are developed in accordance with NERVA data items identified by the GCA.

3.2.5 Real Property Installed Equipment (RPIE)

All RPIE utilized during the NERVA-engine program at the various facilities is maintained by the FHO. All FHO RPIE control documents and procedures are used, providing that the use of these data does not have an adverse impact on program schedules. All GFP utilized in direct support of engine contract end items and their components are maintained by the engine contractor: all other GFP is maintained by the FHO.

3.3 SUPPLY PROGRAM

The objectives of the supply program are to:

1. Minimize the requirement for spares and spares inventory during all phases of the NERVA-engine program.

2. Provide engineering and technical services to ensure that technical literature and trained personnel are available to support all functions which lead to the successful completion of NERVA-engine objectives.

3. Develop AGE during the ground-test program to ensure that qualified OGE/MGE is available to support the NERVA-engine flight program.

3.3.1 Spares

3.3.1.1 Ground Test Program

3.3.1.1.1 Spares Determination

The procedures and concepts delineated herein are designed to provide NERVA engine, NSS, and TSE/AGE spares for the ground-test program. The needed spares are provided as follows:

1. The selection of spare items and determination of quantities selected are based on providing adequate support at minimum cost with a minimum inventory level for each ground test.

2. Initial spares recommendations are made by component designers based on predicted component failure rates.

3. When selecting spare parts, consideration is given to component predicted-failure-rates, failure history (i.e., trend data),

consumption data, condemnation rates, program-readiness needs, facility-maintenance capability (i.e., maintenance level), and turnaround time. The "NERVA Engine Maintainability, Allocation, Assessment, and Analysis Report," (data item R-201), which utilizes the above data as inputs, is used as a guide for the selection and allocation of spare parts.

4. The items to be spared, and quantities of each item to be spared for each NERVA engine or NSS test are an estimate of the spare parts required for minimum support of each test established by program schedules.

3.3.1.1.2 Spare Parts Acquisition

Ground test spares are acquired by compliance with the following requirements:

1. A spare-parts list, covering all items and quantities selected in support of a test, is submitted to the GCA, indicating a recommended quantity therein for each item. The spare-parts list establishes the basis upon which the engine contractor provides spare parts under this phase (i.e., ground test) of the contract.

2. When the items and quantities contained in the spare-parts list and any revisions are acceptable to the GCA, the agency establishes that list to be acceptable by an amendment to the contract.

3. Where possible, orders for approved spare parts are placed concurrently with purchase orders for each item of test hardware.

4. Whenever an approved ECP affects spare parts on order, the contractor amends the spare parts on order in the same ratio as the change affects the CEI and updates the spare-parts list by revision.

3.3.1.2 Flight Program

3.3.1.2.1 Spares Determination

NERVA-engine flight program spares are determined as follows:

1. An engine spare-parts-provisioning guidance conference is held by the GCA and the engine contractor. The purpose of this conference is to be: (1) select NERVA data items which can be used for documenting the spare parts provisioning methods to be used in the flight program; (2) establish ground rules for the period of time to be covered by each provisioning action, method of computing quantities of spares, and the pricing method for spares.

3.3.1.2.2 Spares Acquisition

The engine contractor identifies and provisions the spare parts for the NERVA engine, making maximum use of ground-test-program spares history (i.e., trend data). Any standard Government item identified is provided as GFP where feasible.

Spares and spare parts for RPIE are the responsibility of the FHO.

Spares for GFP used in direct support of a CEI are furnished by the engine contractor. All other spares are furnished by the FHO.

The NERVA-engine supply program is managed by the Support Systems Section, Systems Department, engine contractor's Nuclear Rocket Operations.

3.3.2 Material Management

3.3.2.1 Ground Test Program

3.3.2.1.1 Inventory Control

Under the provisions of this plan, logistics inventory management is established which exercises inventory-management control at the NERVA-engine ground-test site(s). In all matters pertaining to inventory management, the engine contractor's local offsite property administration is under the surveillance of the local GCA's plant-property representative.

A GFP bonded area is established and maintained at AGC-Sacramento, WANL-Large, and NRDS for the purpose of storage, issuance, and shipment of Engine and NSS spare parts and spare parts received from Government sources in support of the program.

3.3.2.1.2 Stock Balance

The stock balance and consumption reporting is as follows:

1. Supply-system stock levels are determined on the basis of overall needs of the various locations with maximum consideration given to component failure ratios (i.e., trend data) and consumption data, and are independent of the facility-site location of the stock.

2. Maximum utilization is made of existing assets.

3. Site stock levels are programmed to vary with anticipated utilization.

4. Accountable records are established and maintained.

5. Movement of serviceable and repairable spare parts between their source and NRDS is coordinated.

The use history of provisioned spare parts is accumulated and reported to the GCA every * days. Use data are collected at the point of issuance and at that time are identified in regards to the particular using location.

3.3.2.1.3 Surplus-Property Disposition

The engine contractor constantly reviews NERVA engine program property for which he has primary responsibility so property in excess of his needs can be identified and disposition procedures promptly initiated.

Surplus and obsolete spare parts which cannot be economically reworked to meet existing requirements and those items which cannot be economically returned to a serviceable condition are disposed of in accordance with existing FHO procedures.

Surplus and obsolete parts which may be economically reworked to meet existing requirements in other programs are transferred in an "as-is" condition.

A review is conducted to compare inventory levels at on- and off-site locations with current requirements and to determine the need for: (1) reallocation; (2) disposal of inventory surplus and obsolete spare parts; (3) cancellation of outstanding orders; (4) adjustment of stock levels; and (5) modification of surplus to a new configuration.

* To be supplied

3.3.2.2 Flight Program

3.3.2.2.1 Inventory Control

The engine contractor establishes logistics inventory management and exercises management control of all NERVA-engine flight program stock locations. In all matters pertaining to inventory management, the engine contractor's local, off-site property administration is under the surveillance of the GCA local plant representative.

A GFP bonded area is established and maintained by the engine contractor at the engine assembly and launch sites for the purpose of storage, issuance, and shipment of engine spare parts and spare parts received from the Government in support of the various programs.

3.3.2.2.1 Stock Balance

The engine contractor controls and directs the stock balance and consumption reporting as follows:

1. Supply-system stock levels are determined on the basis of overall needs of flight-program locations (with maximum consideration given to failure rate and consumption data), and are independent of the facility-site location of the stock.

2. Site stock levels are programmed to vary with anticipated utilization.

3. Maximum utilization is made of existing assets. Where practical, equipment and parts to fill specific requirements are reclaimed from completed laboratory and ground tests. Such equipment and parts are repaired, overhauled, and/or modified to a condition suitable for use in support of program activities.

4. Areas at each site are established and maintained for the purpose of storing, issuing, and shipping that property required to support operations at each location.

5. Accountable records are established and maintained.

6. Movement of serviceable and repairable spare parts between source and offsite locations and between locations are coordinated as required. Movement of subcontractor items is in accordance with the expressed needs of the subcontractor.

7. Consumption-rate data and trend data of the provisioned spare parts are accumulated and reported to the GCA through its plant representative every __*__ days. These data are collected at the point where the spares are used and identified in regards to the use location by quantity; e.g., (five at E-MAD, ten at ETS-1).

3.3.2.2.2 Surplus-Property Disposition

The engine contractor constantly reviews program property for which the organization has responsibility so property in excess of his needs can be identified and disposition procedures promptly initiated as delineated in 3.3.2.1.3.

* To be supplied

3.3.3 Engineering Technical Services

3.3.3.1 Ground Test Program

3.3.3.1.1 Contractor Plant Services

1. Training

The engine contractor develops a training and certification program to ensure that program personnel can provide proficient performance. The training provides familiarization with the NERVA engine, its subsystems and components, and its operational and maintenance requirements.

2. Technical Literature

The engine contractor utilizes the design, functional, and maintenance-analysis data to prepare the required technical literature to support the engine program. This literature includes NERVA-engine familiarization and orientation data.

3. Trained Personnel

The engine contractor provides qualified personnel proficient in nuclear engine, NSS, and component operation assembly and disassembly. The services of these persons are available for cross-contractor and customer consultation and utilization.

3.3.3.1.2 Contractor Field Services (CFS)

1. Training

An evaluation of the operations and tasks identified in "NERVA Engine Requirement Allocation Sheets" (NERVA data item S-53) is

made to ascertain personnel requirements. The engine contractor provides a program for training personnel to fulfill the approved requirements. This training may be performed at the appropriate field facility.

A formal training and certification program is developed to ensure that CFS personnel assigned to NRTS can efficiently and safely accomplish engine and NSS test objectives. Individual programs are developed for the engine and the NSS. Each program is grouped into four major categories: (1) general indoctrination; (2) specific knowledge; (3) operating experience; and (4) simulator training.

General Indoctrination

The indoctrination program provides personnel with a general overall plant knowledge that will enable them to understand the interrelationship of their activities with those of other operational personnel. System descriptions are prepared and then provided to students as a text for the indoctrination program.

Specific Knowledge

Specific-knowledge requirements provide assurance that the operator has satisfactory understanding of the details of his specific plant operation. Personnel receive both oral and written examinations.

Operating Experience

Facility checkouts are used as a mechanism to provide operating experience for personnel prior to operations with a test article. This experience and the performance of the operational tasks determine personnel readiness for duties involving engine and NSS operations.

Simulator Training

The final evaluation of readiness of some personnel is made through simulator training. Checklists for operations are used to conduct this training. Whenever possible, a test system simulator is used to provide a realistic indication of systems operation.

2. Technical Literature

The engine contractor prepares training support data and technical documents. This literature includes engine handbooks, pamphlets, logic diagrams, schematic drawings, operating and maintenance instructions, and other contractor documents suitable for use in conducting training programs.

3. Trained Personnel

The engine contractor provides CFS personnel with the skills requisite to all NRDS test objectives. These personnel are knowledgeable in the principles of operation safety, handling, assembly, and maintenance of the engine subsystems, and components. These persons are assigned to NRDS.

3.3.3.2 Flight Program

3.3.3.2.1 Contractor Plant Services

1. Training

The engine contractor develops a training and certification program to ensure that personnel can perform their tasks with proficiency. The program encompasses the following:

Training and Certification Plan

A training and certification plan is developed. This plan is a working document that is maintained on a current basis throughout the program to reflect system changes, current training program schedules, and methods utilized.

Program Scope

The training program is oriented to provide operator, test, and maintenance personnel with principles of operation, safety, handling, assembly, and maintenance of the engine system. Special training courses are also provided for program planners and "need-to-know" personnel. Training of GCA personnel is provided as necessary.

Training Methods

Training methods include formal classroom training, job-experience training, and on-the-job training. Functional and maintenance analysis documentation, procedures, and test procedures are used to prepare required course material, including a lesson plan, student study guide, examinations, and necessary visual aids. A NERVA-engine handbook is utilized as a text for the training courses.

Plan Coordination

Training requirements, course content, and schedules are coordinated with the GCA.

Administration

Student training records are maintained by the engine contractor.

Follow-On Proficiency Training

Follow-on proficiency training to maintain certification status is provided by the engine contractor.

Certification

The engine contractor provides certification of contractor personnel which encompasses system knowledge, training courses for development of individual skills, and demonstration of individual capabilities in their assigned area of responsibility.

Program Content

The training program is oriented to provide operator, test, and maintenance personnel with principles of operation, safety, handling, assembly, and maintenance of the NERVA engine. Special training courses are also being provided for program planners and "need-to-know" personnel. Training of GCA personnel is provided as necessary. Training is provided in the following areas:

a. Principles of Nuclear Engine and S-N Familiarization

Instruction provides detailed information concerning S-N construction features, assembly, handling, and mating of S-N segments. Special emphasis is placed on the detailed alignment and attachment requirements of the S-N with the launch vehicle, at the launch site. Instruction also covers ground-handling-equipment required to accomplish these tasks.

b. S-N Transportation, Servicing, Storage and Handling

Instruction provides a working knowledge of vehicle-handling and servicing techniques and procedures similar to the activities at the contractor's facilities, NRDS, assembly site, acceptance test site and launch site. Methods, techniques, and inspection requirements are presented. AGE required for the handling, servicing, transportation, and storage is discussed in sufficient detail to ensure accomplishment of these tasks. Pertinent safety precautions and hazard identifications are presented in applicable instructional course segments.

c. S-N Propulsion and Thrust Vector Control

Instruction provides the detailed description of propulsion-system composition, capabilities, and limitations. Discussions on construction features, operational features, electrical sequencing, instrumentation, assembly, handling, and safety precautions provide a working knowledge of the complete system and its associated ground equipment. Instruction in the areas of S-N propulsion and thrust vector control includes: (1) construction of the EPIC; (2) location of components; (3) operation of valves and orifices; (4) pneumatic-system pressurization and leak detection; (5) tank pressures; (6) liquid hydrogen servicing and PSOV operation; (7) vents; (8) connections; and (9) ground-system interfaces. Scheduled and unscheduled maintenance requirements for the TVC system are also discussed.

d. S-N Measurement Equipment Operation and Maintenance

Instruction provides technical training for engine-contractor and subcontractor personnel to operate and perform scheduled and unscheduled maintenance. Data-recording-set modifications,

are described in this course. Operation of required test equipment necessary for testing and checking the functional status of the category of equipment is included in the course.

e. Training Methods

Training methods include formal classroom training, job-experience training, and on-the-job training. Functional and maintenance analysis documentation, procedures, and test procedures are used to prepare the required course material including a lesson plan, student study guide, examinations, and necessary visual aids.

2. Technical Literature

Functional- and maintenance-analysis data are used to prepare procedural support data in support of the NERVA logistics program. These data include training manuals, and operation, maintenance, and transportation procedures. The experience gained during the ground test program is used to update the technical literature used for the flight program.

3. Trained Personnel

CFS personnel are recommended by specialized skill and quantity for each location where needed. The information presented includes the task performed by each person (as well as task specification and its relationship to major systems tasks) and a phasing scheme showing the number of persons required at each location versus real time. The type of CFS representatives required to provide on-site liaison and advisory services is recommended. The CFS program is managed by the Support Systems Section, Systems Department, engine contractors Nuclear Rocket Operations.

3.3.3.2.2 Contractor Field Services

1. Training

The engine contractor develops a training and certification program for plant services which includes a program for CFS personnel.

2. Technical Literature

The technical literature developed for plant services personnel encompasses all field service requirements.

3. Trained Personnel

The engine contractor provides GFS personnel with the skills requisite to all assembly, acceptance-test, and launch-site objectives. These personnel are knowledgeable of the principles of operation, safety, handling, assembly, and maintenance of the NERVA engine, its subsystems, and components and are assigned to each facility.

3.3.4 Test Support Equipment/Aerospace Ground Equipment

The objective of the early phases of the logistics program is to develop OGE/MGE equipment during the ground-test program to assure that equipment is available to support the flight program.

The TSE/AGE requirements are derived from the system engineering process for flight and ground-test missions. This equipment is listed in the "NERVA Engine Test Support Equipment/Aerospace Ground Equipment Plan" (data item M-110), which serves as a collection of support-equipment information and as a communication, planning, and scheduling medium between engine and airframe designers and TSE/AGE designers.

3.3.4.1 Test Support Equipment

The equipment required to support NERVA testing through formal engine qualification testing at ETS-1 is designed, fabricated, and provisioned in accordance with the NERVA-engine TSE/AGE and NERVA management plans. The contractor prepares design sheets for the test support equipment. The engines contractor also is responsible for the design, installation, checkout, testing, and integration of TSE with the appropriate operations group at the facility concerned with the equipment's use.

3.3.4.2 Aerospace Ground Equipment

The equipment required to support the flight program is developed and used where applicable in the NERVA-engine ground-test program to obtain operational-use data and to ensure the baseline and delivery of a "debugged" and qualified AGE. The AGE is designed, developed, fabricated, and provisioned in accordance with NERVA-engine TSE/AGE and NERVA management plans. The engine contractor prepares specifications for flight-program AGE.

3.4 TRANSPORTATION

The objective of the transportation program is to ensure that all deliverable hardware is supplied in a timely manner.

3.4.1 Traffic Management

A traffic-management function is provided, utilizing existing capabilities, to implement this plan in consonance with NERVA-engine program requirements. Traffic-management requirements provide the following:

1. Assurance that transportation capabilities are available to provide movement of all program equipment (including development of movement plans as required) to provide efficient handling and transportation for normal shipment, as well as those items (because of size, shape, and weight) that require specialized handling.

2. Coordination with the GCA traffic officer in those areas that require a combined effort to ensure schedule compliance in accordance with governing publications.

3. Obtainment of routing authorizations from state and local routing clearances.

3.4.1.1 Available Transportation

Traffic-management ensures that approved transportation capabilities are available to provide movement of program equipment and personnel from the plants to the development and qualification testing site, the acceptance test site, the engine, stage, or vehicle assembly site, or the launch site.

3.4.1.2 Carrier Considerations

Traffic management makes the most economical use of available commercial and Government carriers commensurate with SNPO-NPRD-1 requirements. Traffic management also administers the use of GBL's as directed by the GCA.

3.4.1.3 Transportation Time

Traffic management ensures that the movement of equipment is accomplished expeditiously in accordance with contract requirements.

3.4.2 Method of Shipment

3.4.2.1 NERVA Contract End Items

3.4.2.1.1 Nuclear Engine (NE), Nuclear Subsystem Module (NSSM)

The preferred method of shipment for the NE and NSSM between the various locations associated with the program are documented in the system-engineering functional flow diagrams and requirement allocation sheets (data items S-52 and S-53). The engine contractor evaluates the various methods of shipment (i.e., rail, motor carrier, marine, and air) between each location (i.e., contractor's plant, development and qualification test site, acceptance test site, engine and stage assembly site, and launch site) to determine the most economical and reliable method of shipment. The evaluation is documented in a NERVA-engine Trade Study (data item S-54) and submitted to the GCA for approval of the preferred method of shipment. An alternate method of shipment for each item is recommended.

3.4.2.1.2 Aerospace Ground Equipment (AGE)

The method of shipment for all AGE is delineated by the engine contractor in the end-item specifications. Commercial motor carrier is considered as the primary means of movement of AGE between plants and the use sites. Other methods of shipment (i.e., rail, air, or marine) are considered as alternatives in the event that the preferred method becomes unavailable.

3.4.2.2 Non-Nuclear Subassemblies and Components

The method of shipment for non-nuclear subassemblies and components is documented in the NERVA-engine systems-engineering requirement allocation sheets. The engine contractor evaluates the listed methods of shipment (i.e., rail, motor carrier, and air) between use locations to determine the most economical and reliable method of shipment. These evaluations are documented and made available for GCA review.

3.4.2.3 Spares

The method of shipment for all spares is delineated by the engine contractor in the applicable component specification or design sheet. Commercial motor carrier is considered as the primary means of movement of spares between the contractor's plant and the use sites. Air transport (or the most expeditious means available in consonance with contract requirements) is utilized for movement of spares required to return equipment which is delaying critical test, programs, or launch preparations.

3.4.2.4 Test Support Equipment (TSE)

The method of shipment for all TSE is delineated by the engine contractor in the applicable design sheet. Commercial motor carrier is considered as the primary means of movement of TSE between the contractor's

plants and use sites. Other methods of shipment (i.e., rail, air, or marine) are considered as alternatives in the event that the preferred method becomes unavailable.

3.4.2.5 Personnel

Personnel will travel in the most economical and expedient method available.

3.4.3 Transportation Procedural Data

3.4.3.1 Technical Requirements

A packaging technical-requirements data file, which includes material from WANL, is maintained by AGC. WANL maintains an NSS module and associated TSE/AGE technical requirements data file.

Standard packaging information includes:

1. Specialized container design, handling devices, and fixtures.
2. Supplementary data to depict the detailed blocking, bracing, and cushioning requirements.
3. Government bill-of-lading.
4. Procedures developed for the shipment of complex critical and/or exotic materials and components.

3.4.4 Preservation and Packaging (Material Handling Support System)

Packaging requirements are identified as the minimum that will ensure serviceability of material during shipment, handling, and limited storage periods. Preservation is the minimum required for adequate protection against corrosion and deterioration under conditions of normal handling, shipment, and anticipated storage.

The engine contractor prepares specifications and the design for all material handling support systems required to enable movement and placement of the engine and the NSS module and any special environmental control systems required to maintain the specified state of preservation.

The engine contractor designs the packaging and preservation for flight CEI through the component level so their shipment by land, sea, or air is possible.

TSE/AGE and spare parts are reviewed to determine whether specialized shipping and preservation equipment is required to permit proper handling and storage. Shipping and preservation equipment is designed in accordance with NERVA contractual requirements.

3.4.4.1 Air

A detail shipping document is prepared for the transfer of each CEI shipped by air. The document includes data pertinent to the item's shipping routes, natural environment, special transport devices, handling and support systems, and references to applicable trade studies.

3.4.4.2 Land

A detail shipping document is prepared for each CEI shipment by land. This document contains the same data described in paragraph 3.4.4.1.

3.4.4.3 Marine

A detail shipping document is prepared for each CEI shipment by water. This document contains the same data described in paragraph 3.4.4.1.

APPENDIX A

EXPLANATION OF TERMS

Acceptance	An official act by the Government to accept transfer of accountability, title, and delivery of a CEI.
Accountable Records	The transcribed material used to maintain an accurate inventory of property.
Aerospace Ground Equipment (AGE)	That equipment required to support the NERVA-engine flight program after formal engine qualification testing.
Airframe	The assembled structural and aerodynamic components of an aircraft or rocket vehicle that support the different systems and subsystems integral to the vehicle.
Contractor	An individual, partnership, company, corporation, or associate having a contract with the procuring activity for the design and manufacture, or manufacture of article(s) under the terms of a contract.
Cross-Contractor	The service performed by one space systems contractor for any or all other contractors on the same system.
DD 250	A Department of Defense (Material Inspection and Receiving Report) form used to reflect Government inspection and/or acceptance of property.
Depot	An establishment which supplies material and personnel for assembly and installation of a space system.
Down-Time	The element of time (calendar time) during which an item is not in condition to perform its intended function.
Facility Host Organization (FHO)	An organized entity having more or less permanent status at a base, installation or plant to take care of the needs of the personnel or mission units at the facility and the facility. A unit that does what is necessary to keep a facility operational: i.e., supply and maintain.

Field	A functional maintenance area that can perform maintenance beyond the organizational or periodic maintenance levels.
Flight Program (NERVA)	That group of NERVA objectives scheduled to be in after formal engine qualification testing.
Government Bills of Lading (GBL)	A document with which a federal agency pays freight charges for shipment by common carrier and/or contract carrier.
Government Contracting Agency (GCA)	An organization authorized by Congress to represent the United States of America, and enter into agreements to purchase specific services or specific articles for the Government.
Government Furnished Property (GFP)	An asset of the Government usually used to denote CEI's which have previously been formally accepted by the Government, and to denote inventory items.
Ground Test Program (NERVA)	The group of NERVA objectives scheduled to occur through engine formal qualification at ETS-1.
Inventory Control	The methods and/or procedures used maintaining an account that shows the cost and quantity of property received, issued, on order, and on hand, available for issue, dispositioned or scrapped.
Logistics	The segment of a system activity that provides for the maintenance, supply and transportation of the system and its support from initial component ground test through engine flight test at Kennedy Space Center: i.e., equipment facilities and personnel.
Maintainability	A characteristic of design and installation which is expressed as the probability that an item will be retained in or restored to a specified condition within a given period of time, when the maintenance is performed in accordance with prescribed procedures and resources.
Maintenance	All actions necessary for retaining an item in or restoring it to a specified condition.

Appendix A

Maintenance Concept	A guide on how to establish maintenance requirements.
Maintenance Levels	The amount or quantity of maintenance authorized or directed for a specific location.
Maintenance, Corrective	The actions performed, as a result of failure, to restore an item to a specified condition.
Maintenance Cycles	The regular intervals where maintenance is scheduled.
Maintenance, Preventative	The actions performed in an attempt to retain any item in a specified condition by providing systematic inspection, detection and prevention of incipient failure.
Material	All the things required for the equipping, maintenance, operation, and support of the NERVA Test Program activities.
Mating	The act of attaching interfacing subassemblies to each other.
Modification	The physical alteration of a piece of equipment so as to change its capabilities and characteristics.
Nuclear Engine	That system of the Nuclear Stage which converts energy into thrust including all of its support subsystems, i.e., AGE, Facilities, Personnel, and Procedures.
Nuclear Subsystem	That portion of the NERVA Engine which provides and directly controls the thermal energy to the flowing propellant by means of sustaining a nuclear fission process.
Obsolete	No longer satisfactory for the purpose for which it was obtained due to improvements or revised requirements.
Off-Site	A contractor's operations on a Government facility.
On-Site	Contractor's main plant.
Overhaul	The rebuilding, or extensive repair and reconditioning of an item.

Appendix A

Packaging	The wrapping and cushioning of individual items, is not concerned with containers.
Packing	The process of putting items in a shipping container, includes bracketing, bracings, weatherproofing, etc.
P.A.D.	Place of Airborne Debarkation for a launch vehicle; e.g., P.A.D. 19 or 20 at Cape Kennedy.
Priced Spare Parts List	The initial list of spares recommended (to the customer) for system support (by the contractor).
Priced Spare Parts Exhibit	Customer approved list of spares that is added to the contract.
Real Property Installed Equipment (RPIE)	Government owned or leased equipment that is physically attached to, integrated into or built in or on other government owned property and normally procured through the Military Construction Program.
Reallocation	To assign to another location, and/or a different quantity. A change in a previous supply allocation.
Remove/Replace	To remove an item and install a like item.
Repair	The restoration to an operable condition.
Spare	An extra piece of equipment, component, accessory or the like that is held in reserve for use when needed.
Servicing	The replenishment of consumables needed to keep an item in operating condition, but not including any other preventative maintenance or any corrective maintenance.
Site	The specific location of a system or aggregate thereof when said location is federally owned or leased.
Site Activation	To establish an operating capability at a site.
Stock Balance	A stock supply of items in quantities deemed sufficient to meet requirements for a specific period.

Appendix A

Stock Level	The quantity of supplies authorized to be held in anticipation of future demands.
Surplus Property Disposition	The transferral of property considered not usable in the NERVA Propulsion and Test System Program.
Test Support Equipment (TSE)	Test Support Equipment (TSE) is that equipment required to support the NERVA Engine Ground Test Program through engine formal qualification testing at ETS-1.
Transportability	The capability of material to be moved by towing, by self-propulsion, or by carrier, via highways, railways, waterways, pipelines, ocean and airways.